WHAT IS CLAIMED IS:

1. A method for forming a dense composite of silicon nitride and silicon carbide, said method comprising:

(a) mechanically activating a powder mixture of amorphous silicon nitride and silicon carbide in the presence of at most 1% by weight of metal oxide densification aids, said powder mixture consisting essentially of particles less than 100 nanometers in diameter; and

(b) consolidating said powder mixture into a continuous mass by compressing said powder mixture while passing an electric current through said powder mixture, to achieve a fused mass of silicon nitride and silicon carbide crystals.

2. The method of claim **1** in which said mechanically activated powder mixture resulting from step (a) consists essentially of particles of about 1 micron to about 10 microns in diameter, and said fused mass produced in step (b) consists essentially of crystalline grains less than 100 nm in diameter.

3. The method of claim **1** in which said mechanically activated powder mixture resulting from step (a) consists essentially of particles of about 1 micron to about 5 microns in diameter, and said fused mass produced in step (b) consists essentially of crystalline grains less than 50 nm in diameter.

4. The method of claim **1** in which any metal oxide densification aid present in said powder mixture constitutes at most about 0.5% by weight of said powder mixture.

5. The method of claim **1** in which any metal oxide densification aid present in said powder mixture constitutes at most about 0.1% by weight of said powder mixture.

6. The method of claim **1** in which said powder mixture is devoid of metal oxide densification aids.

7. The method of claim **1** in which said powder mixture consists essentially of from about 10 to about 60 parts by volume silicon, from about 10 to about 60

parts by volume carbon, and from about 10 to about 60 parts by volume nitrogen, based on a total of 100 parts by volume of said powder mixture.

8. The method of claim **1** in which said powder mixture consists essentially of from about 10 to about 30 parts by volume silicon, from about 25 to about 50 parts by volume carbon, and from about 25 to about 50 parts by volume nitrogen, based on a total of 100 parts by volume of said powder mixture.

9. The method of claim **1** further comprising forming said powder mixture by pyrolysis of a polyorganosilazane in an inert atmosphere.

10. The method of claim **9** in which said polyorganosilazane is a polyureasilazane.

11. The method of claim **1** in which step (b) comprises compressing said powder mixture at a pressure of about 10 MPa to about 200 MPa and a temperature of from about 900°C to about 3,000°C, and said electric current is a pulsed direct current of about 1,000 A/cm^2 to about 10,000 A/cm^2.

12. The method of claim **11** in which said pressure is about 40 MPa to about 100 MPa.

13. The method of claim **11** in which said temperature is about 1,000°C to about 2,000°C.

14. The method of claim **11** in which said pulsed direct current is about 1,500 A/cm^2 to about 5,000 A/cm^2.

15. The method of claim **1** in which step (b) is performed to achieve a fused mass with a density of at least 95% relative to a volume-averaged theoretical density.

16. The method of claim **1** in which step (b) is performed to achieve a fused mass with a density of at least 98% relative to a volume-averaged theoretical density.

17. The method of claim **1** in which step (b) is performed to achieve a fused mass with a density of at least 99% relative to a volume-averaged theoretical density.

18. The method of claim **1** in which step (a) comprises milling said powder mixture by high-energy ball milling.

19. The method of claim **18** in which said high-energy ball milling is performed with silicon nitride milling balls in a rotary mill at about 6 impacts per second or more and a charge ratio of at least about 10.

20. The method of claim **18** in which said high-energy ball milling is performed with silicon nitride milling balls in a rotary mill at from about 6 to about 60 impacts per second and a charge ratio of about 10 to about 20.

21. A dense composite of silicon nitride and silicon carbide consisting essentially of silicon nitride crystals of less than 100 nanometers in diameter and said silicon carbide crystals of less than 100 nanometers in diameter and containing at most 1% by weight of metal oxide densification aids, produced by a process comprising:

(a) mechanically activating a powder mixture of amorphous silicon nitride and silicon carbide in the presence of at most 1% by weight of metal oxide densification aids, said powder mixture consisting essentially of particles less than 100 nanometers in diameter; and

(b) consolidating said powder mixture into a continuous mass by compressing said powder mixture while passing an electric current through said powder mixture, to achieve a fused mass of silicon nitride and silicon carbide crystals.

22. The dense composite of claim **21** in which said mechanically activated powder mixture resulting from step (a) consists essentially of particles of about 1 micron to about 10 microns in diameter, and said fused mass produced in step (b) consists essentially of crystalline grains less than 100 nm in diameter.

23. The dense composite of claim **21** in which said mechanically activated powder mixture resulting from step (a) consists essentially of particles of about 1 micron to about 5 microns in diameter, and said fused mass produced in step (b) consists essentially of crystalline grains less than 50 nm in diameter.

24. The composite of claim **21** in which any metal oxide densification aid present in said powder mixture constitutes at most about 0.5% by weight of said powder mixture.

25. The composite of claim **21** in which any metal oxide densification aid present in said powder mixture constitutes at most about 0.1% by weight of said powder mixture.

26. The composite of claim **21** in which said powder mixture is devoid of metal oxide densification aids.

27. The composite of claim **21** in which said powder mixture consists essentially of from about 10 to about 60 parts by volume silicon, from about 10 to about 60 parts by volume carbon, and from about 10 to about 60 parts by volume nitrogen, based on a total of 100 parts by volume of said powder mixture.

28. The composite of claim **21** said powder mixture consists essentially of from about 10 to about 30 parts by volume silicon, from about 25 to about 50 parts by volume carbon, and from about 25 to about 50 parts by volume nitrogen, based on a total of 100 parts by volume of said powder mixture.

29. The composite of claim **21** in which said powder mixture is formed by pyrolysis of a polyorganosilazane in an inert atmosphere.

30. The composite of claim **29** in which said polyorganosilazane is a polyureasilazane.

31. The composite of claim **21** in which step (b) comprises compressing said powder mixture at a pressure of about 10 MPa to about 200 MPa and a temperature of from about 900°C to about 3,000°C, and said electric current is a pulsed direct current of about 1,000 A/cm^2 to about 10,000 A/cm^2.

32. The composite of claim **31** in which said pressure is about 40 MPa to about 100 MPa.

33. The composite of claim **31** in which said temperature is about 1,000°C to about 2,000°C.

34. The composite of claim **31** in which said pulsed direct current is about 1,500 A/cm^2 to about 5,000 A/cm^2.

35. The composite of claim **21** in which said fused mass has a density of at least 95% relative to a volume-averaged theoretical density.

36. The composite of claim **21** in which said fused mass has a density of at least 98% relative to a volume-averaged theoretical density.

37. The composite of claim **21** in which said fused mass has a density of at least 99% relative to a volume-averaged theoretical density.

38. The composite of claim **21** in which step (a) comprises milling said powder mixture by high-energy ball milling.

39. The composite of claim **38** in which said high-energy ball milling is performed with silicon nitride milling balls in a rotary mill at about 6 impacts per second or more and a charge ratio of at least about 10.

40. The composite of claim **38** in which said high-energy ball milling is performed with silicon nitride milling balls in a rotary mill at about 6 to about 60 impacts per second and a charge ratio of about 10 to about 20.